Assignment for SP226 Due 04/28/00 Name _____
Chapter 35

2 • Which of the following pairs of light sources are coherent: (*a*) two candles; (*b*) one point source and its image in a plane mirror; (*c*) two pinholes uniformly illuminated by the same point source; (*d*) two headlights of a car; (*e*) two images of a point source due to reflection from the front and back surfaces of a soap film.

3 • (*a*) What minimum path difference is needed to introduce a phase shift of 180° in light of wavelength 600 nm? (*b*) What phase shift will that path difference introduce in light of wavelength 800 nm?

7 •• If the angle of a wedge-shaped air film such as that in Example 35-2 is too large, fringes are not observed. Why?

8 •• Why must a film used to observe interference colors be thin?

9* • A loop of wire is dipped in soapy water and held so that the soap film is vertical. (*a*) Viewed by reflection with white light, the top of the film appears black. Explain why. (*b*) Below the black region are colored bands. Is the first band red or violet? Explain why. (*c*) Describe the appearance of the film when it is viewed by *transmitted* light.

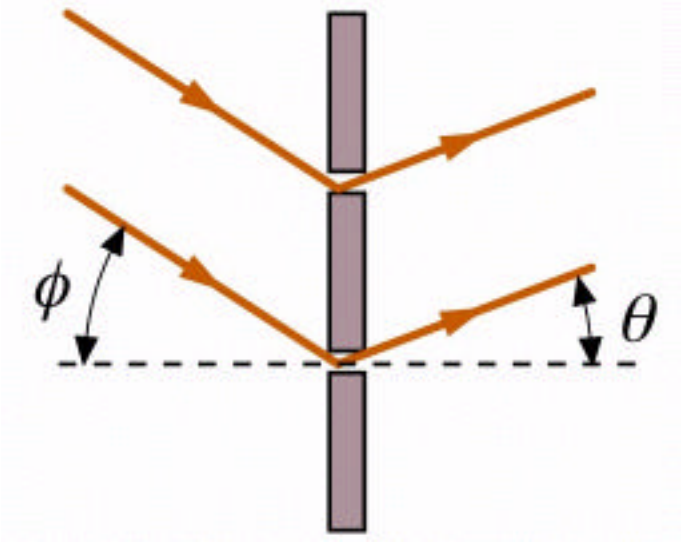
12 •• Light of wavelength 600 nm is used to illuminate normally two glass plates 22 cm in length that touch at one end and are separated at the other end by a wire of radius 0.025 mm. How many bright fringes appear along the total length of the plates?

16 •• A film of oil of index of refraction $n = 1.45$ floats on water ($n = 1.33$). When illuminated with white light at normal incidence, light of wavelengths 700 and 500 nm is predominant in the reflected light. Determine the thickness of the oil film.

20 • A double-slit interference experiment is set up in a chamber that can be evacuated. Using monochromatic light, an interference pattern is observed when the chamber is open to air. As the chamber is evacuated one will note that
(*a*) the interference fringes remain fixed.
(*b*) the interference fringes move closer together.
(*c*) the interference fringes move farther apart.
(*d*) the interference fringes disappear completely.

23 • Light of wavelength 633 nm from a helium–neon laser is shone normally on a plane containing two slits. The first interference maximum is 82 cm from the central maximum on a screen 12 m away. (*a*) Find the separation of the slits. (*b*) How many interference maxima can be observed?

25* •• Light is incident at an angle φ with the normal to a vertical plane containing two slits of separation *d* (Figure 35-40). Show that the interference maxima are located at angles θ given by sin θ + sin φ = *mλ/d*.



27 •• Laser light falls normally on three evenly spaced, very narrow slits. When one of the side slits is covered, the first-order maximum is at 0.60° from the normal. If the center slit is covered and the other two are open, find (*a*) the angle of the first-order maximum and (*b*) the order number of the maximum that now occurs at the same angle as the fourth-order maximum did before.

28 • As the width of a slit producing a single-slit diffraction pattern is slowly and steadily reduced, how will the diffraction pattern change?

29* • Equation 35-2, $d \sin \theta = m\lambda$, and Equation 35-11, $a \sin \theta = m\lambda$, are sometimes confused. For each equation, define the symbols and explain the equation's application.

30 • Light of wavelength 600 nm is incident on a long, narrow slit. Find the angle of the first diffraction minimum if the width of the slit is (*a*) 1 mm, (*b*) 0.1 mm, and (*c*) 0.01 mm.

31 • The single-slit diffraction pattern of light is observed on a screen a large distance L from the slit. Note from Equation 35-12 that the width $2y$ of the central maximum varies inversely with the width a of the slit. Calculate the width $2y$ for $L = 2$ m, $\lambda = 500$ nm, and (*a*) $a = 0.1$ mm, (*b*) $a = 0.01$ mm, and (*c*) $a = 0.001$ mm.

34 • How many interference maxima will be contained in the central diffraction maximum in the diffraction–interference pattern of two slits if the separation d of the slits is 5 times their width a? How many will there be if $d = Na$ for any value of N?

37* •• Suppose that the *central* diffraction maximum for two slits contains 17 interference fringes for some wavelength of light. How many interference fringes would you expect in the first *secondary* diffraction maximum?

40 • Find the amplitude and phase of the resultant E of the two waves $E_1 = 4 \sin \omega t$ and $E_2 = 3 \sin (\omega t + 60°)$.

44 •• Light of wavelength 480 nm falls normally on four slits. Each slit is 2 μm wide and is separated from the next by 6 μm. (*a*) Find the angle from the center to the first point of zero intensity of the single–slit diffraction pattern on a distant screen. (*b*) Find the angles of any bright interference maxima that lie inside the central diffraction maximum. (*c*) Find the angular spread between the central interference maximum and the first interference minimum on either side of it. (*d*) Sketch the intensity as a function of angle.

47 ••• For single-slit diffraction, calculate the first three values of φ (the total phase difference between rays from each edge of the slit) that produce subsidiary maxima by (*a*) using the phasor model and (*b*) setting $dI/d\varphi = 0$, where I is given by Equation 35-20.

52 • You are told not to shoot until you see the whites of their eyes. If their eyes are separated by 6.5 cm and the diameter of your pupil is 5 mm, at what distance can you resolve the two eyes using light of wavelength 550 nm?

56 •• The star Mizar in Ursa Major is a binary system of stars of nearly equal magnitudes. The angular separation between the two stars is 14 seconds of arc. What is the minimum diameter of the pupil that allows resolution of the two stars using light of wavelength 550 nm?

57* • When a diffraction grating is illuminated with white light, the first-order maximum of green light
(*a*) is closer to the central maximum than that of red light.
(*b*) is closer to the central maximum than that of blue light.
(*c*) overlaps the second order maximum of red light.
(*d*) overlaps the second order maximum of blue light.

60 • A diffraction grating with 15,000 slits per centimeter is used to measure the wavelengths emitted by hydrogen gas. At what angles θ in the first-order spectrum would you expect to find the two violet lines of wavelengths 434 and 410 nm?

61* • What is the longest wavelength that can be observed in the fifth-order spectrum using a diffraction grating with 4000 slits per centimeter?

74 • True or false:
(*a*) When waves interfere destructively, the energy is converted into heat energy.
(*b*) Interference is observed only for waves from coherent sources.
(*c*) In the Fraunhofer diffraction pattern for a single slit, the narrower the slit, the wider the central maximum of the diffraction pattern.
(*d*) A circular aperture can produce both a Fraunhofer and a Fresnel diffraction pattern.
(*e*) The ability to resolve two point sources depends on the wavelength of the light.